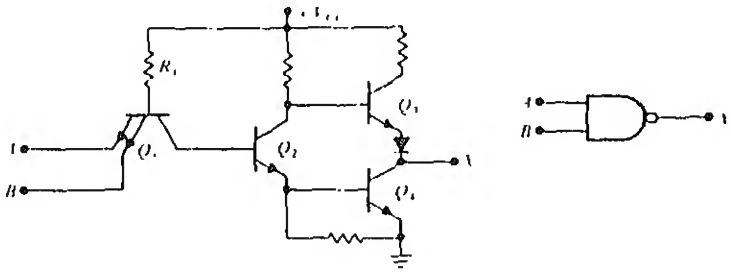
ASSIGNMENT BOOK

FOR

ADVANCED FIRST-TERM AVIONICS COU

CLASS A1

C-100-2010



TTL NAND

UNIT V

CNTT-M1629 Rev.12/84

PREPARED BY

NAVAL AIR TECHNICAL TRAINING CENTER

NAVAL AIR STATION MEMPHIS

MILLINGTON, TENNESSEE

PREPARED FOR

CHIEF OF NAVAL TECHNICAL TRAINING

JANUARY 1983

purpose of this Assignment Book is to assist you through
puter Theory and Troubleshooting, Unit 5, of the Advanced
Avionics Course. The proper use and completion of the
gnments contained in this book will greatly enhance your
rstanding of the material presented in this unit.

table of contents lists the page numbers for safety noti
s schedules, homework schedules, learning objectives, an
gnment Sheets that will further enhance your abilities a
lectronics technicians.

SAFETY NOTICE

s a Navy electronics technician, you will be required to pe
afe and efficient maintenance on various types of electroni
quipment. Not only your life, but the lives of many others
epend on your being safety conscious at all times. It is t
esponsibility of all Navy and Marine Corps. personnel to pr
ccidents. This can be done if everyone develops conscienti
afety habits and observes all precautions when performing
aintenance of any type.

s Assignment Book has been prepared for you to use while y
end the Advanced First-Term Avionics Course. Remember tha
ework is mandatory. When you are in class, the informatio
vided is information you will need in performing your Navy
s volume contains the homework assignments that will direc
dy efforts.

Unit V is two weeks long, and starts in the middle of the f
of the eighth week. The periods run from 317 to 396, with
period finishing half-way through the last day of the tenth

The schedule is as follows:

TOPIC NO.	TYPE	PERIOD	TOPIC
EIGHTH WEEK			
Fifth Day			
4.17	Class	313	Unit/Module Test: Crite
			Written Examination
		314	
		315	
		316	
5.1	Class	317	Introduction to Digital C
		318	
5.2	Class	319	Mathematics of Digital Co
		320	
NINTH WEEK			
First Day			
5.2	Class	321	Mathematics of Digital Co
		322	
		323	
		324	
5.3	Class	325	Basic Logic Gate Interpre
		326	
		327	
		328	
Second Day			
5.3	Class	329	Basic Logic Gate Interpre
		330	
5.4	Class	331	Introduction to the COM-T
		332	Computer and Organization
		333	
5.5	Class	334	COM-TRAN Ten Logic and Da
		335	
		336	

TOPIC NO.	TYPE	PERIOD	TOPIC
Second Day			
5.8	Lab	369	COM-TRAN Ten Data Flow An
		370	
		371	
		372	
5.9	Lab	373	COM-TRAN Ten Fault Isolat
		374	
		375	
		376	
Third Day			
5.9	Lab	377	COM-TRAN Ten Fault Isolat
		378	
		379	
		380	
		381	
		382	
		383	
		384	
Fourth Day			
5.9	Lab	385	COM-TRAN Ten Fault Isolat
		386	
		387	
		388	
	Lab	389	Unit/Module Test: Criter
		390	Performance Test
		391	
		392	
Fiftn Day			
5.9	Class	393	Unit/Module Test: Criter Written Test
5.10	Class	394	Within - Course Comprehens
		395	I, Written Examination and
		396	
6.1	Class	397	Introduction to Airborne F
		398	
		399	
		400	(Demo)

of the Assignment Sheets listed below shall be turned in
Each Assignment Sheet will be checked by an instructor
leteness and correctness. Failure to turn in an Assignme
et could result in disciplinary action.

gnment Sheet	Period Due
1.1A	321
2.1A	329
3.1A	337
4.1A	337
5.1A	337
6.1A	345
7.1A	369

TERMINAL OBJECTIVE

11.0 Isolate an instructor-induced malfunction (under li supervision) in an avionics, general purpose digita computer training device to a weapons replaceable a a shop replaceable assembly, a stage, and a compone record results on job sheets. Test equipment will provided. Performance must be accomplished in acco with COM-TRAN Ten Technical Operations Manual M104, All general and personnel safety precautions must b observed, in accordance with OPNAVINST 5101.2 serie

ENABLING OBJECTIVES

11.1 EXTRACT troubleshooting and performance data from g block and logic diagrams of a general purpose digit computer training device. All circuit performance operating characteristics will be documented on job in accordance with specifications contained in COM- Technical Operations Manual M104, Vol. I.

11.2 PERFORM visual inspections on an avionics general p digital computer training device for physical defec security, integrity, and proper installation and RE results on a job worksheet. Performance must be accomplished in accordance with procedures outlined TRAN Ten Technical Operations Manual M104, Vol. I.

11.3 PERFORM operational and minimum performance checks limited supervision) on an avionics general purpose computer training device and RECORD results on job sheets. Necessary test equipment will be provided. Performance must be accomplished in accordance with Ten Technical Operations Manual M104, Vol. I. All precautions must be observed in accordance with OPN 5101.2 series.

11.4 ISOLATE an instructor-induced malfunction (under li supervision) on an avionics general purpose digital training device to a weapons replaceable assembly, replaceable assembly, a stage, and a component and results on job sheets. Test equipment will be prov Performance must be accomplished in accordance with TRAN Ten Technical Operations Manual. All safety precautions must be observed in accordance with OPN 5101.2 series.

DOCUMENT, on the VIDS/MAF, all necessary corrective a
required in a given maintenance situation to restore
avionics general purpose digital computer training de
an operational condition. Documentation must include
ordering and receipt of parts. All documentation mus
legible and in accordance with OPNAVINST 4790.2 serie

TABLE OF CONTENTS

ASSIGNMENT SHEET 5.1.1A

INTRODUCTION TO DIGITAL COMPUTERS

INTRODUCTION

The purpose of this assignment is to familiarize you with principles of a digital computer system. Once this knowl been mastered, you will be able to troubleshoot a basic d computer system.

LESSON TOPIC LEARNING OBJECTIVES

11.1 EXTRACT troublshooting and performance data from block and logic diagrams of a general purpose di computer training device. All circuit performan operating characteristics will be documented on in accordance with specifications contained in C Technical Operations Manual M104, Vol. I.

11.1.1. SELECT, from a given list, the definition of the classes of computers.

11.1.2. SELECT, from a given list, the computer unit tha determines the overall speed of a digital comput

11.1.3. SELECT, from a given list, the computer unit tha performs an explicit or implicit operation.

11.1.4. SELECT, from a given list, the computer instruct that are used in the control unit.

11.1.5. SELECT, from a given list, the definition of "ra access."

11.1.6. SELECT, from a given list, the definition of a "Volatile memory device."

11.1.7. SELECT, from a given list, the computer units th included in the central processing unit of a dig computer.

11.3 PERFORM operational and minimum performance chec limited supervision) on an avionics general purp computer training device and RECORD results on sheets. Necessary test equipment will be provid formance must be accomplished in accordance with Ten Operations Manual M104, Vol. I. All safety must be observed in accordance with OPNAVINST 5 (series).

supervision) on an avionics general purpose digi
er training device to a weapons replaceable asse
shop replaceable assembly, a stage, and a compon
RECORD results on job sheets. Test equipment wi
vided. Performance must be accomplished in acco
the COM-TRAN Ten Technical Operations Manual. A
precautions must be observed in accordance with
5101.2 (series).

STUDY ASSIGNMENT

Study Information Sheet 5.1.1I and Notetaking Sheet 5.
Complete Assignment Sheet 5.1.1A.

STUDY QUESTIONS

1. The two classes of computers are

   a. _____

   b. _____

2. What are the two types of digital computers?

   a. _____

   b. _____

3. What are the four capabilities of a digital comput

   a. _____

   b. _____

   c. _____

   d. _____

4. Name the five basic units of a general-purpose dig
computer?

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

a. _____

b. _____

c. _____

6. Which units determine the overall speed of a c computer?

a. _____

b. _____

7. List the three basic functions of the control

a. _____

b. _____

c. _____

8. Name the four instructions used in the control

a. _____

b. _____

c. _____

d. _____

9. What are the two categories of arithmetic oper

a. _____

b. _____

10. Define the terms "volatile" and "nonvolatile" to a memory device.

a. _____

b. _____

a. _____

b. _____

c. _____

d. _____

e. _____

12. What are the two modes of access used in a memor

a. _____

b. _____

13. The terms "on line" and "off line" refer to whic units?

a. _____

b. _____

INTRODUCTION

The purpose of this assignment is to provide you with
understanding of binary arithmetic, conversion, numbe
tification, complement arithmetic, computer arithmeti
terminology used to describe machine and mathematical
With this knowledge, the student will be able to trou
a basic digital computer system.

LESSON TOPIC LEARNING OBJECTIVES

11.3.1. SELECT, from a given list, the definition c

11.3.2. SELECT, from a given list, the common numbe
used in digital computers.

11.3.3. CONVERT specified decimal numbers to their
octal, and hexadecimal equivalents.

11.3.4. CONVERT specified octal and hexadecimal num
their decimal and binary equivalents.

11.3.5. PERFORM, with given binary numbers, the ind
arithmetic operations.

11.3.6. SELECT, from a given list, the primary adva
complement arithmetic.

11.3.7. PERFORM, with given binary numbers, the 2's
method of subtraction and addition.

11.3.8. SELECT, from a given list, the method used
negative numbers in the COM-TRAN Ten.

11.3.9. SELECT, from a given list, the method of mu
used in the COM-TRAN Ten.

11.3.10. SELECT, from a given list, the method of di
in the COM-TRAN Ten.

Review Notetaking Sheet 5.2.1N and complete all proble
questions.

STUDY QUESTIONS

1. Match the following terms with their definitions,
B.

A

a. _____Radix

b. _____Radix point

c. _____Bit

d. _____Byte

e. _____Word

f. _____ Modulus

g. _____ Complemen

h. _____ Open-end

i. _____ Closed-en

j. _____ Positiona

B

1. A number system in which the value of a digit
upon the position of the digit within a number

2. The number of discrete conditions a device or
indicate.

3. A set of bits that occupies one storage locati

4. The number of characters used in a number syst

5. The process by which a carry or borrow generat
most-significant digit is brought to the least
significant digit and is added.

6. A binary digit, either a 0 or 1.

7. The dividing point between whole numbers and f

rry or borrow generat
disregarded.

the modulus or highe
to represent the neg

ts acted upon as a ur
ord.

a. A _____

b. B _____

c. C _____

d. D _____

e. E _____

f. F _____

3. Convert the following decimal numbers to binary, octal hexadecimal.

	Binary	Octal	Hexadecimal
a. 69_{10}	_____	_____	_____
b. 36_{10}	_____	_____	_____
c. 77_{10}	_____	_____	_____
d. 127_{10}	_____	_____	_____
e. 46_{10}	_____	_____	_____

4. Convert the following binary numbers to decimal.

a. 11011001_2 _____

b. 111111_2 _____

c. 101011_2 _____

d. 1110101_2 _____

5. Convert the following octal numbers to decimal.

a. 327_8 _____

b. 734_8 _____

c. 26_8 _____

a. $9\ 5_{16}$ _____

b. $1\ 4\ C_{16}$ _____

c. $7\ E_{16}$ _____

d. $5\ A_{16}$ _____

e. $1\ B\ A_{16}$ _____

f. $3\ D\ E_{16}$ _____

7. Convert the following octal numbers to binary.

a. 307_8 _____

b. 47_8 _____

c. 147_8 _____

8. Convert the following hexadecimal numbers to binary.

a. 59_1 _____

b. 36_{16} _____

c. $A6_{16}$ _____

d. $F7_{16}$ _____

e. $24C_{16}$ _____

f. $C9_{16}$ _____

g. $AB3_{16}$ _____

9. Convert the following binary numbers to hexadecimal

a. 11011001_2 _____

b. 10100111_2 _____

c. 11110101_2 _____

d. 10110110111_2 _____

e. 00101101_2 _____

f. 1101011101_2 _____

g. 11101110111_2 _____

h. 1101101102 _____

a. 10110011
+11101001

c. 00111
+10101

b. 10010
+01010

d. 01011101
+11101110

11. Subtract the following binary numbers.

a. 1101
-0110

c. 11111011
-10111110

b. 101101
-011010

d. 11101001
-01110110

12. Multiply the following binary numbers.

a. 101101
x 111

c. 11001101
x 10011

b. 11011011
x 10110

d. 11011
x 101

13. Divide the following binary numbers.

a. 11110 ÷ 101 = _____

c. 11101110 ÷ 1101

b. 0111 ÷ 010 = _____

d. 0110101 ÷ 011

14. What are the two methods of complement arithmetic?

a. _____

b. _____

a. 0110101_2 _____

b. 011101110_2 _____

c. 101011_2 _____

16. Write the following binary numbers in 2's complement

a. 01011101_2 _____

b. 01101110_2 _____

c. 01111111_2 _____

d. 00010010_2 _____

17. What method of complementation is used in the Com-Tr to represent negative numbers?

_____

18. Write the negative hexadecimal value of the followin complemented binary numbers.

a. $1000\ 0001_2$ _____

b. $1110\ 1111_2$ _____

c. $1111\ 1111_2$ _____

d. $1101\ 0001_2$ _____

e. $1000\ 0000_2$ _____

19. Convert the following decimal numbers to binary and using the 1's complement.

a. -14 ----------
- 6 ----------

c. -69 ----------
+49 ----------

b. +23 ----------
-19 ----------

tract, using the 1's complement.

a. -23 ----------
   +19 ----------

b. +16 ----------
   + 5 ----------

c. +54 ----------
   -36 ----------

. Convert the following decimal numbers to binary and add
using the 2's complement.

a. -19 ----------
   +20 ----------

b. -17 ----------
   -10 ----------

c. +19 ----------
   -11 ----------

. Convert the following decimal numbers to binary and sub
tract, using the 2's complement.

a. +15 ----------
   +10 ----------

b. +19 ----------
   -11 ----------

c. -19 ----------
   + 9 ----------

b. Repetitive addition

c. Addition and shift right

d. Shift left

24. The COM-TRAN Ten uses what method of division?

a. Repetitive subtraction

b. Subtract and shift right

c. Shift left

d. Shift left and subtract

25. Convert the following binary numbers to Gray co

a. 0010_2 _____

b. 0110_2 _____

26. Convert the following Gray code numbers to bina

a. 0111 _____

b. 0011 _____

BASIC LOGIC GATE INTERPRETATION

ODUCTION

purpose of this assignment is to provide you with a bas
ledge of the various types of logic gates that are used
ake up a digital computer system. A basic understandin
logic function, operation, and application of the vario
c gates will provide you with the knowledge that will
equired to troubleshoot the COM-TRAN Ten digital comput
em successfully.

ON TOPIC LEARNING OBJECTIVES

.9. SELECT, from a given list, the definition of a lo
symbol.

.10. SELECT, form a given list, the statement describi
positive logic.

.11. SELECT, form a given list, the purpose of the neg
indicator system.

.12. SELECT, from a given list, the truth table that
describes the logic function of a specified logic
gate.

.13. MATCH, from given lists, the logic gate equivalen
the logic gate that produces the same truth table

.14. SELECT, from a given list, the statement describi
operation of an RS latch.

.15. SELECT, from a given list, the statement describi
operation of a "D" edge-triggered flip-flop.

.16. SELECT, from a given list, the statement describi
operation of a single-shot multivibrator.

.17. SELECT, from a given list, the function of a wire
gate.

Y ASSIGNMENT

ew Notetaking Sheet 5.3.1N and complete Assignment Shee
1A.

1. What is the definition of a logic symbol?

_____

2. What is the difference between a basic logic diag
detailed logic diagram?

_____

_____

3. Define the term "positive logic."

_____

_____

4. When using the negation indicator system, the bubl
input of a logic symbol indicates what?

a. Input is statically _____.

b. Active input is _____.

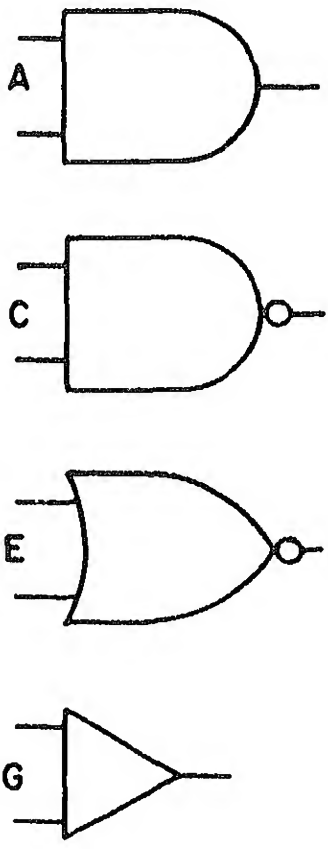
5. When using the negation indicator sytem, the bubbl
output of a logic symbol indicates what?

a. Output is statically _____.

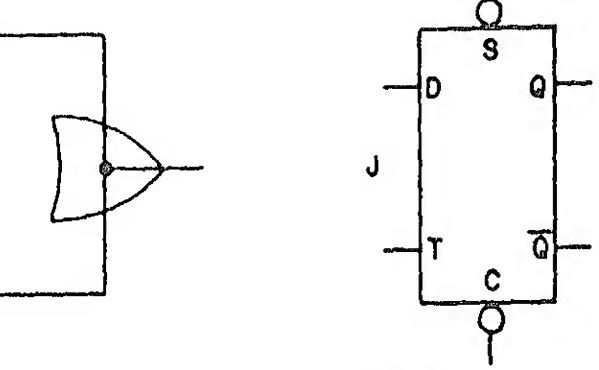
b. Active output is _____.

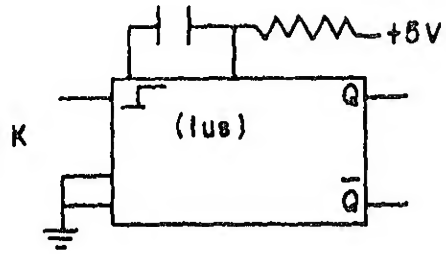
6. Match each term listed in Column A with the symbol
Column B that it describes.

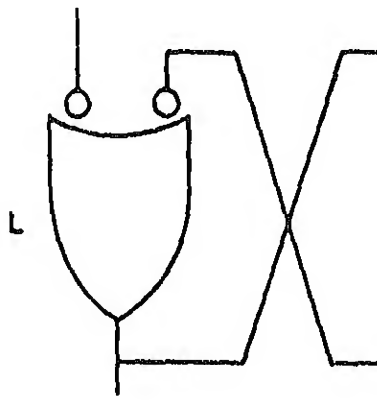
Column A		Col
a.	_____ NOR gate	
b.	_____ Inverter	
c.	_____ Amplifier	
d.	_____ AND gate	
e.	_____ Exclusive OR	
f.	_____ NAND gate	
g.	_____ Wired OR	
h.	_____ Positive AND driver	
i.	_____ R-S latch	
j.	_____ Type "D" Flip-Flop	
k.	_____ Single-shot	
l.	_____ OR gate	



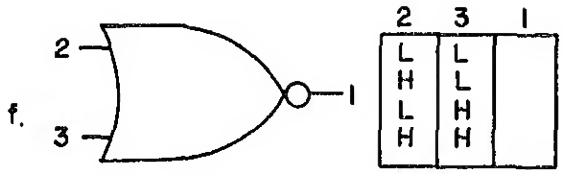
NOTE: Column B
continue
page.

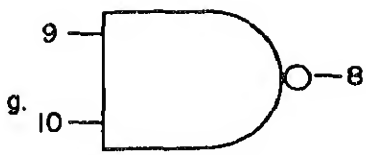


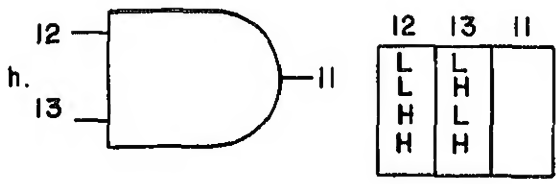


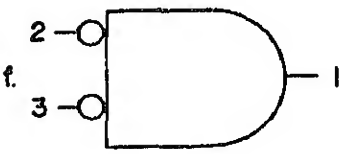


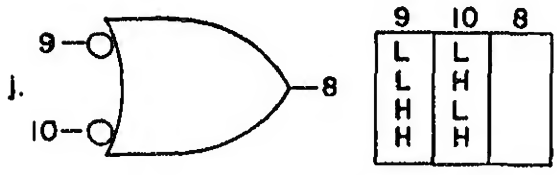
7. Complete the truth tables for the following Logic gates.

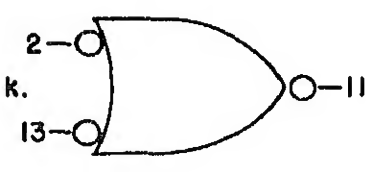


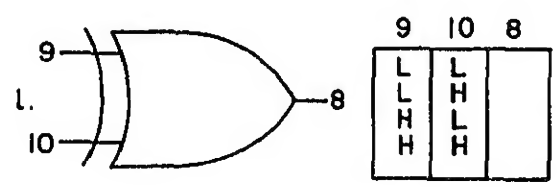




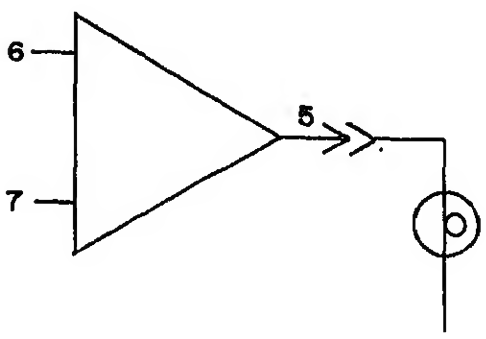




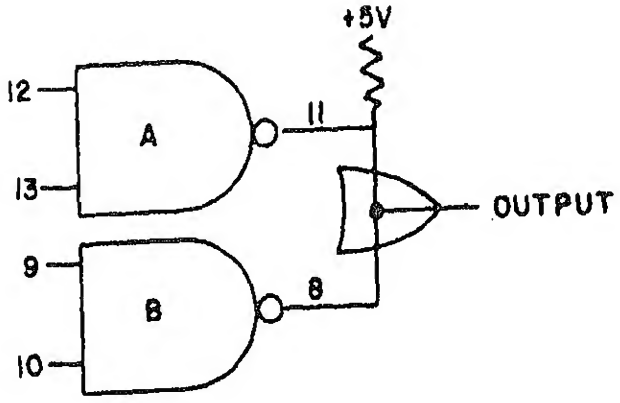




8. What is the condition of the lamp below with a +5 V a
applied to the positive AND driver?

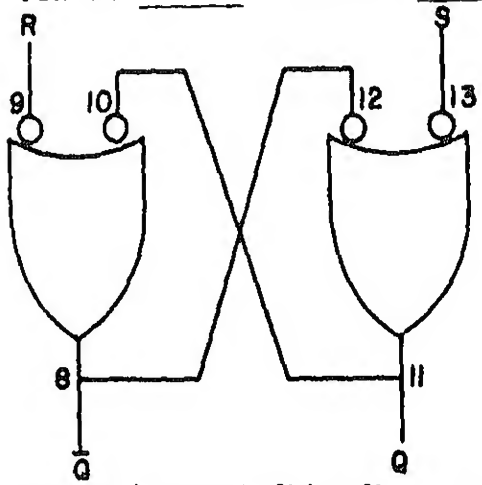


. With two HIGHS applied to NAND gate A what is the output
the wired OR?



0. With a LOW applied to pin 9 and a HIGH applied to pin 13, what is the logic level at the following pins of the R-S latch?

a. Pin 8 _____ Pin 12 _____ Pin 10 _____ Pin 11 _



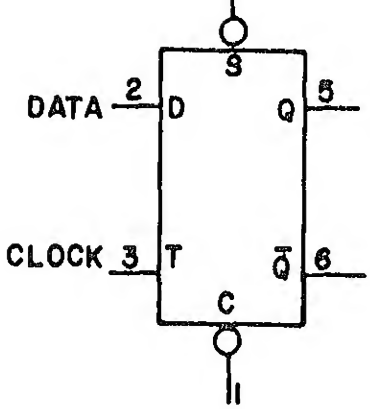
Refer to the "D" edge-triggered flip-flop to answer quest
11, 12, and 13.

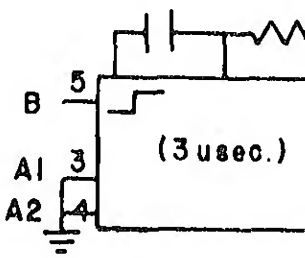
1. What single input will cause the flip-flop to change sta
when the Q-output is HIGH?

_____

2. What will the Q-output be when the "D" input is LOW and
pulse is applied?

input level for the SET and CLEAR inp





Type "D" edge-triggered flip-flop Sin

Refer to the single-shot to answer questions 14, 17.

14. What input trigger is required to produce a posi on the Q-output?

_____

15. When the single-shot is triggered, how log will the unstable state?

_____

16. What determines the pulse width of the Q-output?

_____

17. The single-shot will be triggered on what portic input trigger?

_____

INTRODUCTION

The purpose of this assignment sheet is to provide you
basic knowledge of the COM-TRAN Ten computer. A basic
understanding of the function and purpose of the contro
registers of the COM-TRAN Ten will provide you with the
knowledge that will be required to troubleshoot the COM-
Ten computer.

LESSON TOPIC OBJECTIVES

11.2.11 SELECT, from a given list, the characteristics
COM-TRAN Ten memory unit.

11.3.12 SELECT, from a given list, the arithmetic opera
performed by the arithmetic logic unit.

11.3.13 MATCH the control panel switches with the state
that describe their functions.

11.3.14 MATCH the modes of operation with the statement
describe their functions.

11.3.15 MATCH the counters and registers with the state
that describe their functions.

11.3.16 SELECT, from a given list, the function of the

11.3.17 EXPLAIN the function of the condition code ind
by selecting the correct description from a li
statements.

11.3.18 SELECT, from a given list, the statement that
the purpose of the wait light.

11.3.19 SELECT, from a given list, the statement that
the purpose of the status indicators.

11.3.20 SELECT, from a given list, the statement that
the acquisition phase of an instruction.

11.3.21 SELECT, from a given list, the statement that
the execution phase of an instruction.

Review Notetaking Sheet 5.4.1N and complete all questi

STUDY QUESTIONS

Answer the following questions:

1. What is the capacity of each memory level?

   a. 1024 8-bit words:

   b. 255 8-bit words:

   c. 256 8-bit words:

   d. 1023 8-bit words:

2. List the four arithmetic operations performed by t arithmetic logic unit.

   a. _____

   b. _____

   c. _____

   d. _____

3. The input section of the control panel consists of switches?

   a. _____

   b. _____

   c. _____

escribes its function or purpse.

___(1) Power switch

___(2) Lamp test

___(3) Manual data entry switches

___(4) Reset switch

___(5) HEX data switches

___(6) Register select switches

___(7) RD switch

___(8) WT switch

___(9) REXMT off switch

__(10) HEX mode switch

__(11) ALPHA mode switch

__(12) Clear switch

__(13) Stop switch

__(14) Start switch

__(15) PROG mode switch

__(16) INST mode switch

__(17) A/E mode switch

__(18) DIST mode switch

__(19) RPT mode switch

__(20) Sense mode switch

__(21) INST error bypass

__(22) ADD error bypass

__(23) DIV error bypass

__(24) Read INTRPT switch

a. Set up computer to read da into memory from the telet

b. Computer will attempt to e cute an invalid instructio

c. Sets up computer to write from memory to teletype.

d. Used to read data into or of memory in alphabetical letters, characters, or decimal digits.

e. Computer will continue to operate when the Q-registe exceeds a +127 or a -128.

f. Applied power to the compu

g. Computer will continue to operate when the A-registe exceeds a +127 or a -128.

h. Stops the computer clock.

i. Used to enter data into I- register in binary form.

j. Computer will acquire and execute instructions by internal controls.

k. Clears all registers.

l. Computer will stop after executing one instruction acquiring the next instru tion.

m. Checks all lamps on displ panel and the I-register select switches.

n. Computer will stop after acquisition phase of an instruction.

o. Automatically sets up com to execute a manual outpu instruction.

q. Starts computer clock.

r. Resets the I-register.

s. Used to repeat any mode tion except program mode

t. Automatically sets up co execute a manual input i tion.

u. Used to enter data in he decimal form.

v. Computer will stop after or DPA pulse.

w. Turns teletype printer o

x. Causes computer to perfo in the program when a sk struction is received.

y. Used to read into or out memory in hexadecimal fo

5. Match each of the following counters/registers with the ments that describes its purpose.

____ (1) A-register
____ (2) B-register
____ (3) C-register
____ (4) D-register
____ (5) S-register
____ (6) M-register
____ (7) P-register
____ (8) Q-register
____ (9) X-register
____(10) I-register
____(11) AQ register

a. Holds the count of the process steps to be per a multiply instruction.

b. Holds the multiplier pr execution of a multiply tion.

c. Controls the sequence o timing pulse.

d. Holds the address of th instruction to be acqui memory.

e. Holds the sum after the of an ADD instruction.

f. Holds the product after execution of a multiply instruction.

h. Holds the address of th
tion being executed.

i. Holds the subtrahend du
execution of a subtract
tion.

j. Used for indexing the o
address.

k. Used to hold the data t
input manually into any

6. The condition codes reflect the status of what regist
completion of all but the MPY, DIV, SRA, and SLA inst

a. AQ-register

b. B register

c. A register

d. Q register

7. What mode switch is used to check the acquisition or
phase of each distribution pulse?

a. PROG mode

b. INST mode

c. A/E mode

d. DIST mode

8. The wait light indicates the computer is waiting to:

a. _____

b. _____

a. Op-code register? _____

b. D-register? _____

c. C-register? _____

What registers/circuits control the logic timing of the COM-TRAN Ten?

a. _____

b. _____

c. _____

d. _____

COM-TRAN Ten LOGIC AND DATA FLOW

UCTION

rpose of this assignment is to provide you with a basic
dge of the data flow between the registers of the COM-TR
gital computer. A basic understanding of how and in wha
ce data are transferred will be required for you to trou
the COM-TRAN Ten digital computer successfully.

TOPIC LEARNING OBJECTIVES

EXTRACT troublshooting and performance data from given
and logic diagrams of a general purpose digital comput
training device. All circuit performance and operatin
characteristics will be documented on job sheets in ac
dance with specifications contained in COM-TRAN Ten Te
cal Operations Manual M104, Vol. I.

MATCH designated registers of the COM-TRAN Ten with
statements that describe the sequence of transfer
between them. A copy of the Com-Tran Ten block diagra
will be provided as a reference.

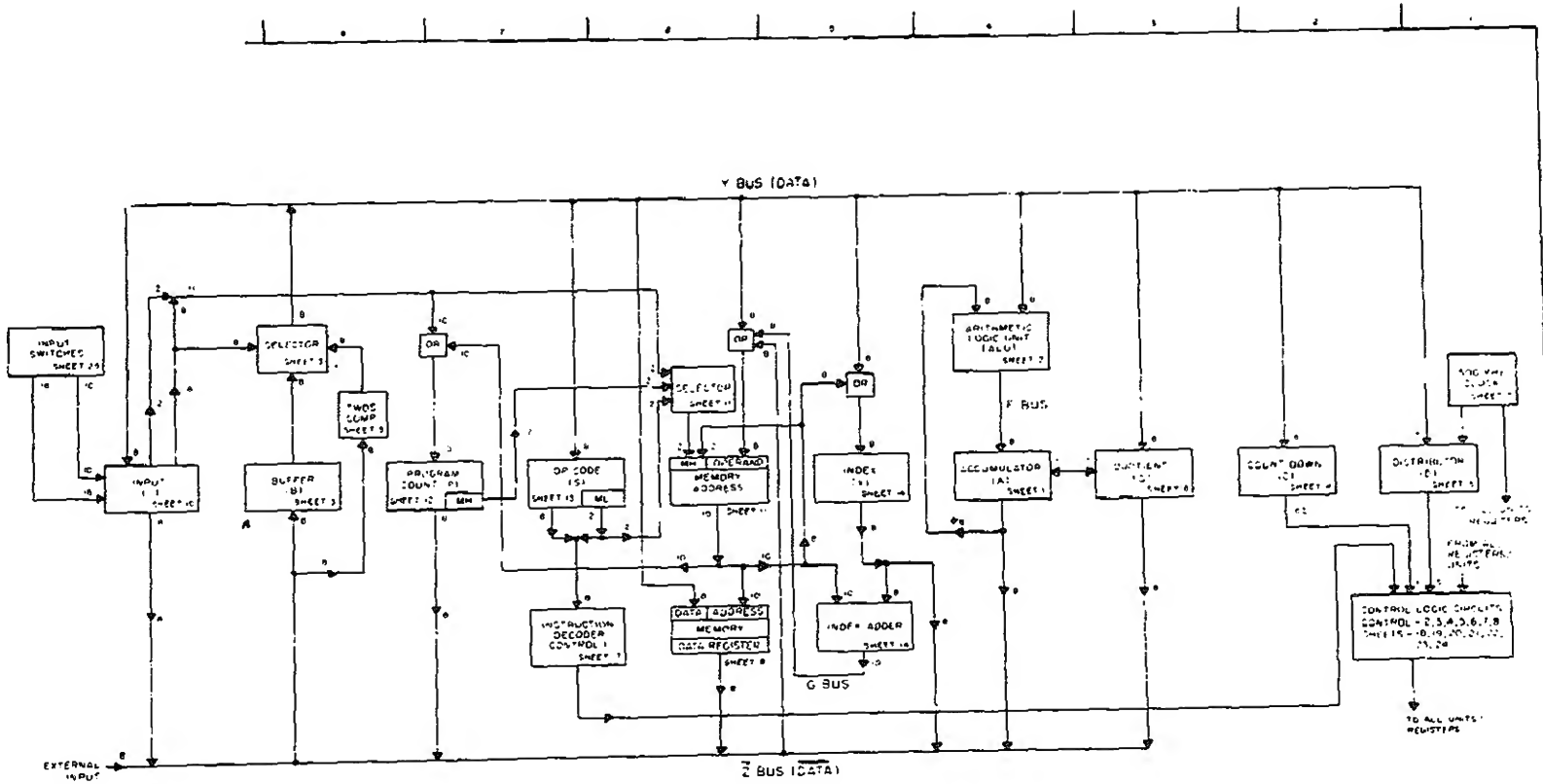
ASSIGNMENT

Notetaking Sheet 5.5.1N and complete all questions.

QUESTIONS

tch the registers of the COM-TRAN Ten digital computer 1
column A with the statements in column B that describe
quence of transfer between them. Refer to the block dia
page 28.

A	B
) I-register to B-register	a. Memory to Z-bus to B-registe selector to Y-bus to ALU to bus to A-register.
) I-register to memory	b. Memory to Z-bus to B-registe selector to Y-bus to S-regis
) I-register to P-register	c. P-register low-order bits to to M-register. P-register h
) I-rgister to M-register	order bits to selector to M- register.
) I-register to S-register	d. Memory to Z-bus to B-registe selector to Y-bus to Q-regis


Y BUS (DATA)
INPUT SWITCHES
SELECTOR
OR
SELECTOR
OR
ARITHMETIC LOGIC UNIT (ALU)
INPUT
BUFFER
PROGRAM COUNTER
OP CODE
MEMORY ADDRESS
INDEX
ACCUMULATOR
QUOTIENT
COUNT DOWN
DISTRIBUTION
F BUS
INSTRUCTION DECODER CONTROL
DATA ADDRESS
MEMORY
DATA REGISTER
INDEX ADDER
G BUS
EXTERNAL INPUT
Z BUS (DATA)
TO ALL UNITS' REGISTERS

(7) I-register to A-register

(8) I-register to Q-register

(9) I-register to C-register

(10) I-register to D-register

(11) P-register to M-register

(12) Memory to S-register

(13) Memory to M-register

(14) M-register to P-register

(15) Memory to teletype

(16) Memory to A-register

(17) Memory to Q-register

(18) Memory to I-register

(19) Memory to X-register

(20) X-register to memory

(21) X-register to M-register

(22) A-register to memory

(23) Q-register to memory

f. Memory to Z-bus to B-regis selector to Y-bus to X-reg

g. Q-register to Z-bus to B-r to selector to Y-bus to me

h. A-register to Z-bus to B-r to selector to Y-bus to me

i. X-register to Z-bus to B-r to selector to Y-bus to me

j. M-register direct transfer P-register.

k. A-register 1 bit transfer register.

l. I-register to selector to S-register.

m. I-register to Z-bus to B-r

n. I-register low-order bits selector to Y-bus to M-reg I-register high-order bits selector to M-register.

o. I-register to Z-bus to B-r to selector to Y-bus to me

p. I-register to selector to X-register.

q. I-register to selector to ALU to F-bus to A-register

r. I-register to selector to Q-register.

s. I-register to selector to C-register.

t. I-register to selector to D-register.

u. I-register direct transfer bits to P-register.

NOTE: The right column is con on the next page.

selector to Y-bus

2. What is the purpose of the control 1 instructor (sheet 17)?

_____

3. The 2's complementor is used to complement the registers?

   a. _____

   b. _____

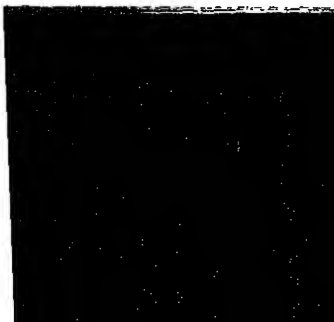
4. What register must all data go through before e leaving memory?

_____

5. The Z-bus is an input bus for what registers?

   a. _____

   b. _____



ODUCTION

purpose of this assignment is to familiarize you with th
ramming steps, flow chart symbols, instruction-word form
ng, instruction repertoire, and machine language of the
TRAN Ten.

ON TOPIC LEARNING OBJECTIVES

.22 MATCH each of the six major steps in programming wi
the term and definition describing it.

.23 SELECT, from a given list, the proper order of the
steps in programming.

.24 MATCH the names of flow chart symbols with statemen
describing them.

.25 SELECT, from a given list, the statement that descr
the difference between a program flow chart and a
system flow chart.

.26 SELECT, from a given list, the statement that descr
the difference between mnemonic and machine languag

.27 SELECT, from a given list, the statement that descr
the COM-TRAN Ten instruction-word format.

.28 MATCH given instructions with statements describing
their functions.

.29 MODIFY the OP CODE, given a list of instructions, t
indicate the second, third, or fourth level of memo
by writing each code in the appropriate column.

.30 MODIFY the OP CODE, given a list of instructions, t
indicate indexing and the first level of memory by
writing each code in the space provided.

.31 SELECT, from a given list, the purpose of indexing.

.32 SELECT, from a given list, the statement that descr
the operation of a specified Load instruction.

.33 SELECT, from a given list, the statement that descr
the operation of a specified Store instruction.

.34 SELECT, from a given list, the statement that descr
the operation of a specified Arithmetic instruction

11.3.35 SELECT, from a given list, the statement that
the operation of a specified Logical instruct

11.3.36 SELECT, from a given list, the statement that
the operation of a specified Branch instructi

11.3.37 SELECT, from a given list, the statement that
the operation of a specified Input/Output ins

11.3.38 SELECT, from a given list, the definition of
routine.

11.3.39 LIST, with the aid of the HSI and a program u
TRAN Ten instructions, the contents of a spec
register after each instruction has been exec

STUDY ASSIGNMENT

Read Notetaking Sheet 5.6.1N and complete the assignm

STUDY QUESTIONS

1. Match each of the programming steps in column A wi
and definition describing it in column B.

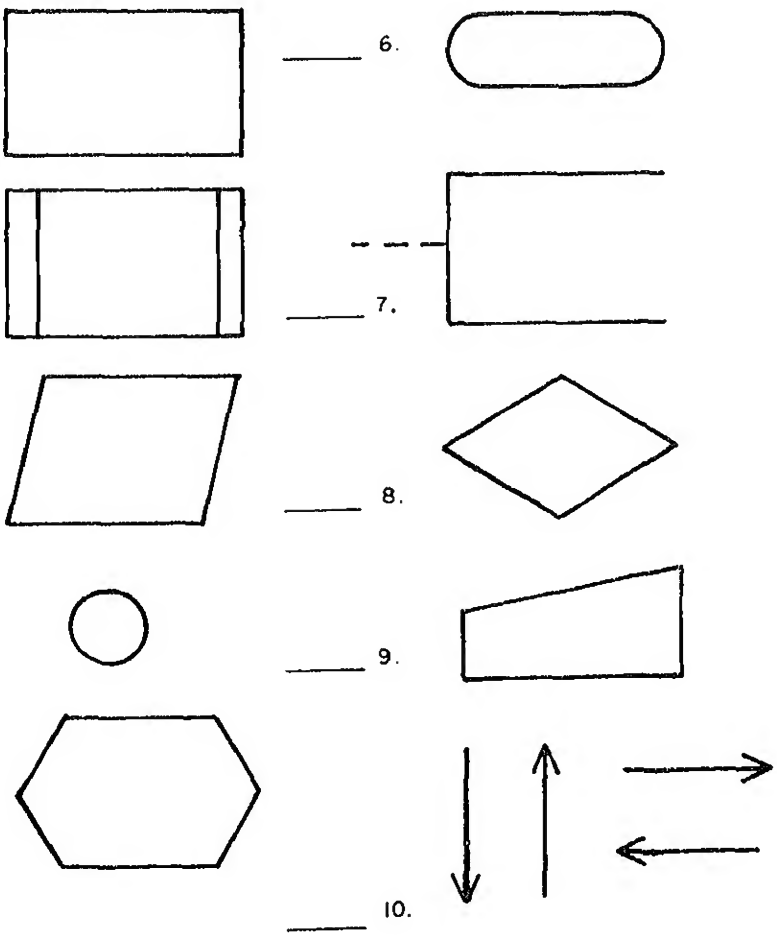
Column A	Column B
____ 1. Step 1	a. Debugging--the process errors in the program.
____ 2. Step 2	b. Coding--the process of the operations in the into a language the co understand.
____ 3. Step 3	c. Write a clear comprehe ment of the problem.
____ 4. Step 4	d. Analysis--of the probl susceptible to arithme logical computation.
____ 5. Step 5	e. Execution--of a progra
____ 6. Step 6	f. Flow chart--A graphic tion in which symbols denoting various opera showing the sequence i are to be performed.
	g. Documentation--Is an e material, flow chart, tions for the computer and other information the program.

ting the letter sequencing each term in column B in the
propriate blank in column A.

A		B	
_ 1.	Step 1	a.	Coding
_ 2.	Step 2	b.	Analysis
_ 3.	Step 3	c.	Statement
_ 4.	Step 4	d.	Documentation
_ 5.	Step 5	e.	Debugging
_ 6.	Step 6	f.	Flow chart

tch the flow chart symbols in column A with their function
umn B.

A



B

a. Input/ output

b. Connec

c. Manual input

d. Decisi

e. Prepar tion

f. Termir

g. Proces

h. Flowli

i. Pre- define proces

j. Annota tion

_____ 1. A system flow chart represents a complete
the program; whereas, a progrm flow chart
only a portion of the program.

_____ 2. A system flow chart represents a general
of the problem; whereas, a program flow c
sents a step-by-step sequence of the oper
a program.

_____ 3. A system flow chart represents a general
of the problem; whereas, a program flow c
sents a general approach between flow cha
and program instructions.

5. Which statement best describes the difference betw
language and mnemonics?

_____ 1. Machine language is a binary expression t
computer can understand; whereas, mnemoni
alphabetical expressions that label and s
individual instructions.

_____ 2. Machine language is a numeric expression
struction, while a mnemonic is an alphabe
for an instruction name given as an aid t
memory.

_____ 3. Machine language is an alphabetical expre
instruction, while a mnemonic is a numeri
of an instruction.

_____ 4. Machine language is an alphabetically exp
struction; whereas, mnemonics are binary
which computers can readily understand.

6. List and define the two parts of the COM-TRAN Ten
word.

1. _____

2. _____

Match the instructions in column A with their function in column B.

A		B	
___	1. LCI	a.	Load the A-register with the contents of th memory address indicated by the OPERAND.
___	2. MNI	b.	Branch to the memory address indicated by OPERAND if condition code ">0" is set.
___	3. LXI	c.	Shift the AQ-register left the number of places indicated by the OPERAND.
___	4. BSB	d.	Increase the contents of the X-register by the value indicated by the OPERAND.
___	5. LAN	e.	Add one to the contents of the memory address indicated by the OPERAND.
___	6. ADD	f.	Load the A-register with the 2's complement of the memory address indicated by the OPERAND.
___	7. BPS	g.	Add the contents of the memory address indicated by the OPERAND to the A-register, leaving the result in the A-register.
___	8. BST	h.	Load the X-register with the value indicated by the OPERAND.
___	9. MPY	i.	Load the C-register with the value indicated by the OPERAND.
___	10. RAO	j.	Multiply the A-register by the contents of the memory address indicated by the OPERAND leaving the results in the AQ-register.
___	11. DIV	k.	Branch unconditionally to the memory address indicated by the OPERAND.
___	12. BUN	l.	Branch to the memory address indicated by OPERAND and STOP.
___	13. LDA	m.	Transfer the contents of the I-register to the memory address indicted by the OPERAND
___	14. SLA	n.	Divide the AQ-register by the contents of memory address indicted by the OPERAND, leaving the quotient in the Q-register and the remainder in the A-register.
___	15. INX	o.	Store a BUN OP CODE at the memory address indicated by the OPERAND. Store the conte of the P-register at the next memory addre after the one indicated by the OPERAND (M+ then branch to the second memroy address after the one indicated by the OPERAND (M+

Indicate the 2nd, 3rd, or 4th levels of memory by wri
code in the appropriate column.

		Second level	Third level	Fo
1.	LAN			
2.	ADD			
3.	BST			
4.	DIV			
5.	LDA			
6.	BSB			
7.	STA			
8.	MPY			
9.	RAO			
10.	BUN			
11.	BPS			

9. Modify the OP CODES of the following instructins to
indexing and the 1st level of memory by writing each
the space provided.

1.	LAN	
2.	ADD	
3.	BST	
4.	DIV	
5.	LDA	
6.	BSB	
7.	STA	
8.	MPY	
9.	RAO	
10.	BUN	
11.	BPS	

Which statement best describes the purpose of "indexing"?

____ 1. A programmer uses indexing to locate a bit of information during the program operation.

____ 2. Indexing allows the programmer to repeat an operation throughout a section of memory.

____ 3. Indexing is changing a portion of the control memory t allow the selection of specific information.

____ 4. Indexing is the selection of the location where certai subroutines will be located.

Which statement best describes the action of the "store" instructions?

____ 1. The "store" instructions are all register-to-register operations.

____ 2. The OPERAND of the "store" instructions specifies the register that will be acted upon during the execution of the instruction.

____ 3. "Store" instructions store the contents of the registe specified by the OP CODE into the memory address contained in the OPERAND of the instruction. The content of the registers are not altered.

____ 4. The "store" instructions are immediate addressing instructions; that is, the value in the OPERAND is place into the specified register upon the execution of the instruction.

Which statement best describes the action of the ADD and SUB instructions?

____ 1. The ADD instruction adds the contents of the memory address to the contents of the accumulator and places the result into the memory address specified by the OPERAND.

____ 2. The ADD instruction adds the contents of the Q-registe to the contents of the accumulator and places the result into the accumulator.

____ 3. The ADD instruction adds the contents of the OPERAND t the contents of the accumulator and places the result into the accumulator.

____ 4. The SUB instruction subtracts the OPERAND from the OP CODE and places the result into the accumulator.

____ 5. The SUB instruction subtracts the contents of the OPERAND from the contents of the accumulator and place the result into the accumulator.

(Cont'd on next page)

result into the accumulator.

. Which statement best describes the action of the MPY instruct

____ 1. The MPY instruction arithmetically multiplies the OPERAND and the memory address specified by the OP C and places the result into the accumulator.

____ 2. The MPY instruction multiplies the accumulator by th OPERAND and places the product into the AQ register.

____ 3. The MPY instruction multiplies the accumulator by th contents of the specified memory address (+1), then logically "ANDS" the result with the previous data i the accumulator.

____ 4. The MPY instruction multiplies the contents of the accumulator register with the contents of the memory address and places the results in the AQ-register.

. Which statement best describes the action of the DIV instructi

____ 1. The divisor is in the AQ-register and the dividend i in the memory address.

____ 2. The OP CODE for the DIV instruction is "78."

____ 3. The DIV instruction divides the contents of the AQ-register by the contents of the memory address specified in the OPERAND. The quotient is placed into th Q-register, and the ramainder is placed into the accumulator.

____ 4. The DIV instruction cannot handle two numbers whose quotient will exceed the bit-length of the Q-registe

Which statement best describes the action of the SLA instructi

____ 1. The SLA works on the AQ-register only.

____ 2. The SLA instruction shifts the double-length AQ-regis to the right the number of bit positions determined i the OPERAND portion of the instruction. It "pads" th Q-register with zeros.

____ 3. The SLA instruction shifts the accumulator to the rig and the Q-register to the left in a combined operatio that results in all bits being lost, regardless of th count in the OPERAND.

____ 4. The SLA instruction shifts the double-length AQ-register to the left for a shift count determined by OPERAND. It "pads" the low-order bit of the Q-regist with zeros.

tion as shown in the program below?

____ 1. The BUN at '70' was generated and stored as a p of the execution of the BSB instruction at loca '46'.

____ 2. The OPERAND portion of the instruction word at is the address in the main program to which the computer will branch upon execution of the BSB instruction.

____ 3. The subroutine ends with address '82'.

____ 4. The BUN, '70' at location '82', causes the sub- routine to be performed again and again up to a maximum of $FF_{(16)}$ times for each iteration.

____ 5. The OPERAND portion of the instruction word at is the address in the main program to which the computer will return after the completion of th subroutine.

____ 6. The BUN, '70' at memory address '82', sends the program control back to the main program after completion of the subroutine via the BUN, '48' location '70'.

Program Address	Mnemonic Coding	Comment
'42'	LAI, 00	Make believe initialization of regi
'44'	LXI, 0E	other memory locations, in other wo a part of previous programming, etc
'46'	BSB, 70	BRANCH TO SUBROUTINE. The BSB is g to send the program to '70'.
'48'	??	The program continues from this poi
..	...	after the completion of the instruct
..	...	in the subroutine.
..	...	
..	...	
'70'	BUN, 48	The BUN is generated by the BSB, th '48' is the next instruction after BSB.
'72'		Beginning of the subroutine instruc- tions.
..		
..		
..		
..		
'82'	BUN, 70	

instruction?

____ 1. It informs the computer to output one data bl
the peripheral.

____ 2. It informs the computer to output a block of
to the peripheral.

____ 3. It informs the peripheral to output a block c
to the computer.

____ 4. It informs the computer to input a block of m
from the peripheral.

8. Which of the following instructions are "input" instru
for the COM-TRAN Ten?

____ 1. Write until interrupt (WDI).

____ 2. Read data block (RDB).

____ 3. Input data block (IDB).

____ 4. Read until interrupt (RDI).

____ 5. Write data block (WDB).

9. Which statement describes the definition of a "subrout

____ 1. A program designed to utilize wasted memory
locations in order to fill all memory locatic

____ 2. A maxi-program that allows the computer to ha
repetitive task.

____ 3. A mini-program that allows the computer to ha
repetitive tasks.

____ 4. A program which allows the computer to handle
repetitive tasks.

Analyze the following programs and list the contents of the Accumula
and Quotient after the execution of each instruction.

RAM ESS	OPERATION CODE		OPERAND		ACCUMULATOR
	MNEMONIC	"HEX" CODE	MEMORY ADDRESS M	DATA WORD K	
	LDA	20	08		
	SRL	18		03	
	ADD	60	09		
	BST	98	00		
	VARIABLE		1A		
	VARIABLE		05		
					ACCUMULATOR
	LDA	20	4E		
	ADD	60	4F		
	STA	48	4E		
	SLL	13		01	
	SUB	68	4F		
	STA	48	4F		
	BST	98	00		
	VARIABLE		07		
	VARIABLE		02		

21. Analyze the following program and list the contents
Accumulator and Quotient after the execution of eac
instruction.

PROGRAM ADDRESS	OPERATION CODE		OPERAND		ACCU
	MNEMONIC	"HEX" CODE	MEMORY ADDRESS M	DATA WORD K	
200	LCI	01		02	
202	MNI	F2	24		
204	LDA	22	24		
206	ADD	62	26		
208	STA	4A	2A		
20A	LDA	22	25		
20C	MPY	72	26		
20E	STQ	5A	2C		
210	LDA	22	25		
212	ADD	62	26		
214	MPY	72	24		
216	SLA	08		08	
218	SUB	6A	2C		
21A	SRA	10		08	
21C	DIV	7A	2A		
21E	BST	9A	00		
224	VARIABLE		A=0A		
225	VARIABLE		B=08		
226	VARIABLE		C=04		
22A			A+C		
22C			BC		

002	MNI	F0	14		
004	LDA	20	14		
006	BSB	A0	18		
008	STQ	58	16		
00A	LDA	20	15		
00C	BSB	A0	18		
00E	SLA	08		08	
010	ADD	60	16		
012	BST	98	00		
014	VARIABLE	A = 03	B = 04		
016	PRODUCT		M_3		
018	BUN	(001)	(001)		ACCU
01A	STA	48	17		
01C	MPY	70	17		
01E	SLA	08		08	
020	MPY	70	17		
022	BUN	90	18		
					ACCU

NTRODUCTION

he purpose of this assignment is to provide you with a ba
nowledge of the operation and logic organization of the C
en registers and units.

ESSON TOPIC LEARNING OBJECTIVES

1.1.18 SELECT, from given lists, COM-TRAN Ten operations specified inputs, and commands and subcommands to various registers and units, using the COM-TRAN T logic diagrams.

1.1.19 SELECT, from given lists, factors in the logic or zation of the COM-TRAN Ten, using the COM-TRAN Te logic diagrams.

TUDY ASSIGNMENT

ead paragraphs 2-11-1 through 2-11-13 in the HSI. Read N aking Sheet 5.7.1N and complete the assignment below.

TUDY QUESTIONS

efer to logic sheet 7 to answer the following questions:

. What is the count in the two D-type flip-flops (8GA ar when $\overline{CP2}$ is low?

____A. 00 (gc)

____B. 01 (gc)

____C. 10 (gc)

____D. 11 (gc)

. What is the pulse width of the $\overline{ENABLE}$ signal?

____A. 6 microseconds

____B. 8 microseconds

____C. 2 nanoseconds

____D. 16 nanoseconds

When will this occur?

____A. When the $\overline{\text{ENABLE}}$ is LOW.

____B. When the two D-edge-triggered flip-flops are
1 state.

____C. When the two D-edge-triggered flip-flops are
0 state.

____D. When $\overline{\text{SPCK}}$ is HIGH.

4. What inputs to the single-shot 6H are required to tri
Gray code counter continually?

____A. A LOW on pin 5 and an upclock on pins 3 and 4

____B. A LOW on pin 5 and a downclock on pins 3 and 4

____C. A HIGH on pin 5 and an upclock on pins 3 and 4

____D. A HIGH on pin 5 and a downclock on pins 3 and

efer to logic sheet 5 to answer the following questions:

. The true conditions, D0, D1, D2, and D3 are taken from
flip-flop output?

____A. $\overline{Q}$

____B. D

____C. Q

____D. S

What clocks the D-register through its sequential count

____A. CP1 upclock

____B. CP2 upclock

____C. CP3 upclock

____D. $\overline{\text{ENABLE}}$

____D. Y6

8. What clock pulse clears the I-register loaded from the Y-bus?

____A. CP1

____B. CP2

____C. CP3

____D. Enable

9. Which hex input switch does not input generates ICLK when pressed?

____A. Hex F

____B. Hex 1

____C. Hex 0

____D. Hex 9

Refer to logic sheet 3 to answer the following

10. When will the B-register be loaded fr

____A. When the leading edge of CP2 a

____B. When the trailing edge of CP2 a

____C. When the leading edge of CP2 a

____D. When the trailing edge of CP2 a

3, 8C), what is felt at pin 7)?

____A. Pin 4 input.

____B. Pin 5 input.

____C. Pin 6 input.

____D. One's complement input.

12. If the A and B inputs to the selector are LOW (the condition), what is on the Y-bus?

____A. The I-register.

____B. The B-register.

____C. The complement of the B-register.

____D. The complement of the I-register.

Refer to logic sheet 8 for the following questions:

13. Which of the following signals are not used to wri formation into memory?

____A. $\overline{IBS}$

____B. Y-BUS input

____C. $\overline{M0}$ through $\overline{M9}$

____D. $\overline{ISB}$

14. If the data word being read from memory is FF(16), voltage level will be felt at NAND gate 7K-A, pin

____A. 0 volts

____B. +5 volts

15. How long is the $\overline{IBS}$ signal on pin 4 of 9L-B?

____A. 2 microseconds

____B. 6 microseconds

____C. 8 microseconds

____D. As long as the LDA instruction is in the S

What signals are necessary to increment the Memory Addr register by 1?

____A. $\overline{\text{TGM}}$ and $\overline{\text{CP3}}$

____B. $\overline{\text{TPM}}$ and CP3

____C. $\overline{\text{TIM}}$ and CP2

____D. $\overline{\text{TBM}}$ and CP2

What locic levels are needed on pins 2 and 14 of data selector 13 J to transfer S0 and S1 to M8 and M9?

____A. Pin 2 HIGH and pin 14 HIGH.

____B. Pin 2 HIGH and pin 14 LOW.

____C. Pin 2 LOW and pin 14 HIGH.

____D. Pin 2 LOW and pin 14 LOW.

From what register/s does the M-register receive inform at $\overline{\text{DPA8}}$?

____A. S-register only.

____B. I-register via the Y-bus.

____C. B-register and S-register.

____D. P-register via the Z-bus.

What signals will load the M-register from the Z-bus?

____A. $\overline{\text{DPA8}}$ and CP2

____B. $\overline{\text{TMB}}$ and CP2

____C. $\overline{\text{TIM}}$ and $\overline{\text{CP3}}$

____D. $\overline{\text{TPM}}$ and CP2

20. What signals are necessary to add the Index regis
M-register and transfer the results to the M-regi

____A. TXB

____B. $\overline{\text{TMX}}$ and CP2

____C. LX and CP2

____D. AXM, $\overline{\text{TGM}}$, and $\overline{\text{CP3}}$

21. What happens if the sum of the Index register and
M-register exceeds 10-bit places?

____A. The Index register end carries.

____B. The overflow bits are lost.

____C. The carry light is set.

____D. The ADD overflow light is set.

22. What logic levels are felt on pins 1, 3, 8, and 1
11E and 11D when the AXM signal is LOW?

____A. The contents of the X-register.

____B. 11111110 (2)

____C. 00000001 (2)

____D. 00000000 (2)

Refer to logic sheet 12 to answer the following questi

23. What signals are needed to load the P-register fr
M-register?

____A. $\overline{\text{TMP}}$ LOW, $\overline{\text{TIP}}$ HIGH, and CP2.

____B. $\overline{\text{TMP}}$ HIGH, $\overline{\text{TIP}}$ HIGH, and CP2

____C. $\overline{\text{TIP}}$ LOW, TPLB, and CP2.

____D. $\overline{\text{TMP}}$ LOW, $\overline{\text{TIP}}$ LOW, and CP2.

ಎಂಬುವಂತಾಯಿತು ಇವಳಿಗೆ. ಕೃಷ್ಣಪ್ರೇಮದ ಪರಾಕಾಷ್ಠೆಯಲ್ಲಿರುವವಳು ಇವಳು. 'ಕಾಚಿದಾವಸಥಸ್ಯಾಂತೇ ಸ್ಥಿತ್ವಾ ದೃಷ್ಟ್ವಾವ ಬಹಿರ್ಗತಂ। ತನ್ಮಯತ್ವೇನ ಗೋವಿಂದಂ ದಧ್ಯೌ ಮೀಲಿತಲೋಚನಾ॥ ಎಂದೂ 'ಯಯೌ ಚ ಕಾಚಿತ್ ಪ್ರೇಮಾಂಧಾ ತತ್ಪಾರ್ಶ್ವಂ ಅವಿಲಂಬಿತಂ' ಎಂದೂ ಹೇಳಿರುವಂತಾಯಿತು ಇವಳ ದೆಸೆ. 'ಪ್ರೇಮದಿಂದ ಕತ್ತಲೆ ಕವಿದಿತು. ಆ ಕತ್ತಲೆಯೇ ದಾರಿ ತೋರಿಸಲು ಅವಳು ಅವನ ಬಳಿ ಸಾರಿದಳು'—ಎಂದು ಕಂಡು ಬರುತ್ತದೆ. ಅವಳನ್ನು ಎಲ್ಲರೂ ನಿಂದಿಸುತ್ತಿರಬೇಕಾದರೆ ಅವಳು ಹೇಳುವುದೇನು ಎಂದರೆ 'ಆಶ್ಚರ್ಯಂ ಗುಣಚೇಷ್ಟಿತನೇ, ಮಾಧವನೇ'—ಎಂದು. 'ನಿನ್ನನ್ನು ಪರಮ ಪ್ರಣಯಿಯನ್ನಾಗಿ ಮಾಡುವ ಶ್ರೀದೇವಿಗೆ ವಲ್ಲಭನೇ'—ಎಂದು ಹೇಳಿಕೊಳ್ಳುತ್ತಾಳೆ.

ಆಶ್ರಿತರಿಗಾಗಿ ನೂರಾರು ಬಗೆಯಲ್ಲಿ ಜನಿಸಿದರೂ 'ನಾನೇನೂ ಮಾಡಲಾಗಲಿಲ್ಲವಲ್ಲ! 'ಋಣಂ ಪ್ರವೃದ್ಧಂ ಇವ'-ಎಂದು ಹೇಳುವ ಸ್ವಭಾವದವನಾಗಿ ಆಶ್ರಿತರ ಬಗೆಗೆ ವ್ಯಾಮೋಹವನ್ನುಳ್ಳವನು ಅವನು. ತನ್ನನ್ನು ಸ್ಮರಿಸಿದವರ ಜನ್ಮವನ್ನು ಕಳೆದು ಹಾಕುವ ಪ್ರಭಾವವುಳ್ಳ ಶ್ರೀನಾಮಂಗಳನ್ನು ಉಳ್ಳವನು. ದುಃಖನಿವರ್ತಕವಾದ ಆ ನಾಮಂಗಳು ಇವಳಿಗೆ ದುಃಖವನ್ನುಂಟು ಮಾಡುತ್ತಿವೆ! 'ರಕ್ಷಿತಾ ಜೀವಲೋಕಸ್ಯ' ಎಂಬುವ ಹಿರಿಮೆ ಇವನದು ತನ್ನ ಆನೃಶಂಸ್ಯವನ್ನು ಕೊಂಡಾಡದ ನಿತ್ಯಸೂರಿಗಳಿಗೆ ನಿತ್ಯವೂ ಸೇವೆಯನ್ನು ಕೊಡುವವನು ಇವನು. ಇವಳ ಬಗೆಗೆ ಅವನು ಮಾಡಿದ ಆನೃಶಂಸ್ಯ ವ್ಯಾಪಾರಗಳನ್ನು ನನ್ನಿಂದ ಹೇಳಿ ಮುಗಿಸುವುದಕ್ಕಾಗುವುದಿಲ್ಲ!—

ಪಂದೋಡು ಕಟಲ್ ಮುರುವಾಳ್ ಪೈಂಗಿಳಿಯೆಂವರ್
ಪಾಲೂಟ್ಟಾಳ್ ಪಾವೈಪೇಣಾಳ್
ವಂದಾನೋ ತಿರುವರಂಗಂ ವಾರಾನೋ
ಏನ್ರೆನ್ರೇ ವಳ್ಳಿಯುಂ ಶೋರುಂ
ಶಂದೋಹನ್ ಪೌಲಿಯೆನ್ ಐನ್ದು ಅಟಲ್ ಓಂಬು
ಶೈತ್ತಿರೀಯನ್ ಶಾವುನೇದಿ
ಅನ್ದೋ ವನ್ದು ಎನ್‌ಮುಹಳ್ಳೈ ಶೆಯ್‌ದನಹಳ್
ಆಮ್ಮನೈಮೀರ್ ಅರಿಹಿಲೇನೇ ॥೯॥

(ಪಂದೋಡು ಕಟಿಲ್ ಮರಂವಾಳ್) ನನ್ನ ಮಗಳು ಚೆಂಡನ್ನೂ ಕಾಲಂದುಗೆಯನ್ನೂ ಮರಂಟ್ಟುವುದಿಲ್ಲ. (ಪೈಕಿಳಿಯರಂಪಾಲೂಟ್ಟಾಳ್) ತನ್ನ ಚೆಲುವಾದ ಗಿಳಿಗೆ ಹಾಲನ್ನು ಕುಡಿಸುವುದೂ ಇಲ್ಲ. (ಪಾವೈಪೇಣಾಳ್) ಆಟಕ್ಕೆ ತಕ್ಕುದಾದ ಮರದ ಬೊಂಬೆಯ ಕಡೆ ನೋಡುವುದೂ ಇಲ್ಲ. (ತಿರುವರಂಗಂ ವಂದಾನೋ ವಾರಾನೋ ಎನ್ರು ಎನ್ರೇ) ಶ್ರೀರಂಗನಾಥನು ಬಂದುಬಿಟ್ಟನೇ? ಬರಲಾರನೋ? ಎಂದು ಹೇಳಿಕ್ಕೊಂಡು (ವಳ್ಳಿಯುಂ ಶೋರುಂ) ಕೈಬಳೆಗಳು ಜಾರಿ ಬೀಳುತ್ತಿರಲು ನಿಂತೇ ಇದ್ದಾಳೆ. (ಶಂದೋಹನ್) ಛಾಂದೋಗ್ಯೋಪನಿಷತ್ಪ್ರತಿಪಾದ್ಯನೂ (ಪೌಟ್ಟಿಯನ್) ಕೌಷೀತಕಿ ಬ್ರಾಹ್ಮಣ ಪ್ರತಿಪಾದ್ಯನೂ, (ಐನ್ದು ಅಟಿಲ್ ಓಮ್ಬು) ಪಂಚಾಗ್ನಿಗಳಿಂದ ಆರಾಧಿಸಲ್ಪಡುವವನೂ, (ತೈತ್ತಿರೀಯನ್) ತೈತ್ತಿರೀಯೋಪನಿಷತ್ಪ್ರತಿಪಾದ್ಯನೂ (ಶಾಮವೇದಿ) ಸಾಮವೇದ ಪ್ರತಿಪಾದ್ಯನೂ ಆದ ಪರಬ್ರಹ್ಮಾತ್ಮನು (ವಂದು) ಈ ಜಾಗಕ್ಕೆ ಬಂದು (ಎನ್ ಮಹಳೈ ಶೆಯ್ದನಹಳ್ ಅಮ್ಮನೈಮೀರ್, ಅರಿಹಿಲೇನ್, ಅನ್ನೋ) ನನ್ನ ಮಗಳ ವಿಷಯದಲ್ಲಿ ಏನಾಡಿದುದನ್ನು, ತಾಯಿಯರೇ, ನಾನು ತಿಳಿಯಲಾರದವಳಾಗಿದ್ದೇನೆ!

ನಿದ್ರಿಸುವ ಸಮಯದಲ್ಲಿಯೂ ನನ್ನ ಮಗಳು ಚೆಂಡನ್ನೂ ಗೆಜ್ಜೆಯನ್ನೂ ಕೈ ಬಿಡದೆ ಇದ್ದವಳು ಈಗ ಅವುಗಳನ್ನು ಮುಟ್ಟುವುದೂ ಇಲ್ಲ. ತನ್ನ ಮುದ್ದಿನ ಗಿಳಿಗೂ ಹಾಲೂಡಿಸುವುದಿಲ್ಲ. ಆಟದ ಬೊಂಬೆಯನ್ನು ಕಣ್ಣೆತ್ತಿಯೂ ನೋಡುವುದಿಲ್ಲ. 'ಬಾಲ್ಯೇ ಕ್ರೀಡನಕಾಸಕ್ತಾಃ ಯೌವ್ವನೇ ವಿಷಯೋನ್ಮುಖಾಃ! ಆಜ್ಞಾ ನಯಂತ್ಯಶಕ್ತಾ ಽಽಚ ವಾರ್ಧಕ್ಯಂ ಸಮುಪಸ್ಥಿತಾಃ॥ ತಾಸ್ಮಾದ್ಬಾಲ್ಯೇ ವಿವೇಕಾತ್ಮಾ ಯತೇತ ಶ್ರೇಯಸೇ ಸದಾ!' ಎಂಬುವುದಕ್ಕನುಗುಣವಾಗಿ ಎಲ್ಲವನ್ನೂ ಬಿಟ್ಟಂತೆ ಕಾಣುತ್ತದೆ. ಹೀಗೆ ಬಿಟ್ಟವರು ಯಾರಾದರೂ ಉಂಟೋ ಎಂದರೆ 'ಪರಿತ್ಯಕ್ತಾಮಯಾಲಂಕಾ' ಎಂದೂ ವಿಭೀಷಣನ ಬಗೆಗೆ ಕಾಣಬಹುದು; ಅಪನೇ ಪ್ರಾಪ್ಯವೆಂಬ ಅರಿವು ಮೂಡಲು ಉಳಿದವೆಲ್ಲಾ ಪ್ರಾಪ್ಯಾಭಾಸಗಳಾಗಿ ತ್ಯಾಜ್ಯವಾಗುವುವಷ್ಟೇ? ಅವನು ಬರುವುದು ನಿಶ್ಚಿತವೆಂದೇ ಇದ್ದಾಳೆ. ಅವನು ಬಂದರು ಮುಖ ತೋರನೇ? ನಾನು ಈ ದೆಶೆಯೊಡನೆ ಮಂಗಿದರು ಹೋಗುವುದಷ್ಟೇಯೇ? ಆಟದ ಬೊಂಬೆಗಳೋಪಾದಿ ಕೈಬಳೆಯೂ ಕಳಚಿ

ಬಿದ್ದಿತು. 'ಅನುರಾಗೇಣ ಶೈಥಿಲ್ಯಮುಪಾಸ್ಯಾಸಂ ವ್ರಜತೋ ಹರೇಃ । ಶೈಥಿಲ್ಯ ಮಂಪಯಥಾಂತ್ಯಾಶಂ ಕರೇಷು ವಲಯಥಾನ್ಯಪಿ ॥' ಎಂಬುವಂತಾಯಿತು.

ಈ ಕೆಲಸವನ್ನು ಒಬ್ಬ ಅಜ್ಞನು ಮಾಡಿದ್ದರೆ ಸಹಿಸಿಕೊಳ್ಳಬಹುದಾಗಿತ್ತು. 'ವೇದೈಶ್ಚ ಸರ್ವೈರಹಮೇವ ವೇದ್ಯಃ ವೇದಾಂತವಿದ್ವೇದವಿದೇವ ಚಾಹಂ'—ಎನ್ನುವ ಹಿರಿಮೆಯನ್ನುಳ್ಳ ಸರ್ವಜ್ಞನೇ ಈ ರೀತಿ ಮಾಡಿದವನು! ಒಬ್ಬನು ಅವಿವೇಕಿ ಮಾಡುವಂತೆ ಸರ್ವಜ್ಞನು ಮಾಡಿದರೆ ನಾನೆಲ್ಲಿ ತಾನೇ ಹೋಗಿ ಸೇರಬಲ್ಲೆ? ಅವನೇ ಬಂದು ಹೀಗೆ ಮಾಡಿಬಿಟ್ಟು ತಾನೇ ಉಪೇಕ್ಷಿಸ ಬಹುದೇ?

ಶೇಲ್ ಉಹಳುಂ ವಯೆಲ್ ಪುಡೈಶೂಟ್
ತಿರುವರಂಗತ್ತಮ್ಮಾನೈ ಶಿಂದೈಶೆಯ್ದ
ನೀಲಮುಲರ್‌ಕಣ್ ಮುಡವಾರ್ ನಿರೈಅಟ್ಟಿವೈ
ತಾಯ್‌ಪೊಟ್ಟಿಂದ ಅದನೈ ನೇರಾರ್
ಕಾಲನೇಲ್ ಪರಕಾಲನ್ ಕಲಿಕನ್ರಿ
ಒಲಿಮಾಲೈ ಕತ್ತುವಲ್ಲಾರ್
ಮಾಲೈಶೇರ್ ವೆಣ್‌ಕುಡೈಕೀಟ್ ಮನ್ನರಾಯ್ತ್
ಪೊನ್ನುಲಹಿಲ್ ವಾಟ್‌ವರ್‌ತಾಮೇ ॥೧೦॥

(ಶೇಲ್‌ಉಹಳುಂ) ಮೀನುಗಳು ಚಿವಿಕ್ಕನಲಿಯುತ್ತಿರುವಂಥ (ವಯಲ್‌ಪುಡೈ ಶೂಟ್) ಗದ್ದೆಗಳಿಂದ ಸುತ್ತಲೂ ಸುತ್ತುವರಿಯಲ್ಪಟ್ಟಿರುವ (ತಿರು ಅರಂಗತ್ತು ಅಮ್ಮಾನೈ) ಶ್ರೀರಂಗದಲ್ಲಿರುವ ಸ್ವಾಮಿಯನ್ನು (ಶಿಂದೈಶೆಯ್‌ದ) ಧ್ಯಾನಿಸಿ ಕೊಂಡಿರುವ (ನೀಲಮಲರ್‌ಕಣ್‌ಮಡವಾರ್) ಕನ್ನೈದಿಲೆಯಂತೆ ಕಣ್ಣು ಗಳನ್ನುಳ್ಳ ಪರಕಾಲನಾಯಕಿಯ (ನಿರೈಅಟ್ಟಿವೈ) ಲಜ್ಜೆ, ನಾಣು ಇವುಗಳಂ ಅಳಿದುಂದನ್ನು ಕುರಿತು (ತಾಯರ್ ಮೊಟ್ಟಿನ್ದ ಅದನೈ) ತಾಯಿ ಹೇಳಿದ ಮಾತು ಗಳ ರೂಪದಲ್ಲಿ (ನೇರಾರ್ ಕಾಲನ್) ಶತ್ರುಗಳಿಗೆ ಯಮನಂತಹವರೂ, (ವೇಲ್) ವೇಲಾಯುಧ ಧಾರಿಗಳೂ (ಪರಕಾಲನ್) ಪರಕಾಲರೆನ್ನುವ ಶ್ರೀ ನಾಮವನ್ನುಳ್ಳವರೂ, ಆದ (ಕಲಿಕನ್ರಿ) ತಿರುಮಂಗೈ ಆಳ್ವಾರ್ ಆವರು (ಒಲಿ ಮಾಲೈ) ಹಾಡಿದ ಈ ನುಡಿಮಾಲೆಯನ್ನು (ಕತ್ತುವಲ್ಲವರ್‌ತಾಮ್) ಓದಿ ಅರಿಯಲು ಬಲ್ಲವರು (ಮಾಲೈಶೇರ್ ವೆಣ್‌ಕುಡೈಕೀಟ್) ನುಂಚ್ಚಿನ ಸರಗಳು

ತೂಗಾಡುವ ಶ್ವೇತಚ್ಛತ್ರದ ನೆರಳಿನಲ್ಲಿ (ಮನ್ನವರ್ ಆಯ್) ರಾಜರಂಗಳಾಗಿದ್ದು ಕೊಂಡು ಈ ಲೋಕದ ಐಶ್ವರ್ಯವನ್ನು ಅನುಭವಿಸಿದ ನಂತರ (ಪೊನ್ ಉಲಹಿಲ್ವಾಟ್ವರ್) ಪರಮಪದದಲ್ಲಿ ನಿತ್ಯಾನುಭವವನ್ನು ಮಾಡುವವರಾಗುತ್ತಾರೆ.

ತಿರ್ಯಕ್ಕುಗಳೂ ಸಹ ನಲಿದಾಡುವಂತಹ ಗದ್ದೆಗಳಿಂದ ಸುತ್ತುವರಿಯಲ್ಪಟ್ಟ ಶ್ರೀರಂಗದಲ್ಲಿರುವ ಸರ್ವೇಶ್ವರನನ್ನು ಧ್ಯಾನಿಸುತ್ತಾ ತನ್ಮಯಳಾದ ಪರಕಾಲ ನಾಯಕಿ ತನ್ನ ಸ್ತ್ರೀತ್ವವನ್ನು ಅಳಿಸಿಕೊಂಡ ಬಗೆಯನ್ನು ಅಪಳ ತಾಯಿಯು ನುಡಿಗಳಲ್ಲಿ ನಿರೂಪಿಸಿದ್ದಾರೆ ಆಳ್ವಾರ್ ಅವರು. ಈ ಆತ್ಮ ಸಂದರ್ಭವನ್ನು ಸಮೀಚೀನರಾದ ಆಚಾರ್ಯರ ಉಪದೇಶದಿಂದ ಅರಿಯುವವರು ಪರವಾತ್ಮನ ಶ್ವೇತಚ್ಛತ್ರಿಯ ನೆರಳಲ್ಲಿ ಸಾರುವವರಾಗಿ, ಅವನ ಕೈಯಿಂದಲೇ ಮಾಲೆಯನ್ನು ಪಡೆಯುಬಲ್ಲ ಸ್ವರವಟ್ಟುಗಳಾಗಿ ಶ್ರೀವೈಕುಂಠದಲ್ಲಿ ಭಗವಂತನ ನಿತ್ಯಾನುಭವವನ್ನು ಮಾಡುವವರಾಗಿ ಬಾಳುತ್ತಾರೆ.

ತಿರುಮಂಗೈ ಆಳ್ವಾರ್ ತಿರುವಡಿಹಳೇ ಶರಣಂ